

Talk the talk: Learner-generated podcasts as catalysts for knowledge creation

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Abstract

Podcasting allows audio content from one or more user-selected feeds or channels to be automatically downloaded to one's computer as it becomes available, then later transferred to a portable player for consumption at a convenient time and place. It is enjoying phenomenal growth in mainstream society, alongside other Web 2.0 technologies that enable Internet users to author and distribute rich media content quickly and easily. Instead of using the technology for the mere recording and dissemination of lectures and other instructor-centred information, the project reported on in this article focused on enabling students to create their own podcasts for distribution to their peers. The article describes how engaging in the podcasting exercise promoted collaborative knowledge building among the student-producers, as evidenced through focus-group interviewing and an analysis of the products of their shared dialogue and reflection. The findings suggest that the collaborative development of audio learning objects enabling student conceptualisations of disciplinary content to be shared with peers is a powerful way of stimulating both individual and collective learning, as well as supporting social processes of perspective-taking and negotiation of meaning that underpin knowledge creation.

Background and introduction

The aim of the study described in the present paper was to enable a group of volunteer undergraduate students to create digital audio clips, structured as weekly, 3 to 5 minute talkback radio-style 'shows', and share them with their peers through podcasting. It was hoped that by listening to background material and by being exposed to the terminology of the subject area, members of the student audience would be better prepared to participate in classes. The authors believed that in this way, the podcasts could be part of an effective solution to help alleviate the listeners' preclass anxiety and allay their

concerns about issues such as assessment, thereby preparing them to participate in classes with greater motivation and confidence (Chan & Lee, 2005). The intended outcomes for the student-producers were to develop digital literacy skills, foster generic attributes such as teamwork, and enable them to express and conceptualise their understanding of subject matter.

The design of the podcast shows is based around the concept of having two or more of the student-producers engage in informal discussion on pertinent issues related to the unit and its content. The lecturer and other subject matter experts are occasionally brought in as 'guests' on the shows to offer insight into, or clarification of, the more complex issues and topics. This approach is consistent with the idea of a digital audio learning object (DALO) (Middleton & McCarter, 2005), defined as 'a digital audio file that can be used, and reused, in various learning situations and that supports a distinct learning objective using an appropriate and engaging method' (p. 5).

The project was initially piloted with a student audience consisting of a single cohort studying a first-level information technology (IT) unit on Internet technology and Web authoring, entitled ITC125 Information Superhighway, at the Wagga Wagga campus of Charles Sturt University. The scope of the project later expanded to encompass other units of study, involving undergraduate and postgraduate students in both IT as well as other disciplines, for a campus-based audience as well as for students studying off-campus in various locations around Australia and overseas. The production of the podcasts for the various units was driven entirely by the group of volunteer students, with minimal lecturer intervention in the process. The present article focuses on the knowledge-building and construction processes that these student-producers engaged in as they worked individually as well as collaboratively as a team. The study is significant in demonstrating tangible learning outcomes that are resulting from the growing adoption of Web 2.0 applications in university teaching and learning internationally (O'Reilly, 2005).

Educational podcasting: an overview

Adam Curry (2004), of MTV fame, is credited with having first coined the term 'podcast', a portmanteau that combines the words 'iPod' (the name of Apple Computer's popular music player) and 'broadcast'. Curry observed several user-experience problems with the available bandwidth speeds and using these to broadcast media across the Internet. His solution involves having a computer that is continuously online so that bandwidth-intensive content can be 'dripped in' and made available when ready.

The process of monitoring user-selected podcast feeds for updates and downloading new content is automated by software known as an aggregator or 'podcatcher'. This allows the user to experience a 'true sense of broadband' (ibid., para. 4), in contrast to the click and wait situation common in streaming, which refers to playing media as it downloads. In this sense, podcasting has been likened to a TiVo or similar device that

uses a process of time shifting to allow for flexible viewing at a time convenient to the user.

Once downloaded, audio podcasts can be transferred to a variety of portable devices, including but not limited to dedicated music players such as the iPod, handheld computers, as well as many modern mobile phones and personal digital assistants. Users without access to such devices can simply listen to the content on their desktop computers.

Using podcasting to support learning in higher education

There has been significant uptake of portable music players and podcasting, both in mainstream society and in education. Jon Udell (2005, cited in Campbell 2005) attributes this growth to five main factors:

1. The pervasiveness of the Internet;
2. The rapid growth of broadband;
3. The widespread availability of the multimedia personal computer;
4. The blurring of the distinction between streaming and downloading media content; and
5. The rapid uptake of portable MPEG Layer 3 (MP3)-capable devices.

Since late 2002, various courses at Georgia College and State University (2005), including a number of study-abroad courses, have been 'iPod-enhanced' to include a diverse range of audio material ranging from lectures and audio books to language-study material and music. In August 2004, Duke University (2006) distributed 20-gigabyte iPods to its 1650 commencing students, preloaded with orientation information. Administrative and academic materials in MP3 format are available for students to download from the Duke Web server and via Apple iTunes. In a smaller scale project, Drexel distributed iPod Photo players to its School of Education freshmen in September 2005 (Read, 2005). Other major universities that have implemented podcasting at an institutional level include University of California, Berkeley (2006), Princeton University (2005) and Stanford University (n.d.). Apple hosts iTunes U (Apple Computer, 2005), a free service for colleges and universities that provides easy access to audio and video content such as lectures and interviews, using the same technology as the commercial iTunes Music Store.

Beyond recorded lectures

Schlosser (2006) reminds us that '[t]he use of audio in education is not new, but is experiencing a renaissance fuelled by the ubiquity of portable audio players, broadband Internet, and software tools that allow the relatively easy creation and distribution of audio files' (sec. 2, para. 1). Most existing uses of podcasting in higher education focus on the use of the technology to deliver instructional content such as lectures, which can lead to issues of pedagogical soundness and cause one to question the ultimate educational value of adopting this nascent technology over other, more mature technologies that have been in existence for many years. This is symptomatic of what Salaberry (2001) terms a 'technology-driven pedagogy'. Used appropriately, however, podcasting

can enhance classroom learning by engaging students in the material and adding yet another modality of learning (Carson, 2006).

There have been very few published examples of podcasting being used within the higher education sector to empower students and encourage active learning, and even fewer based around learner-generated podcasts (McLoughlin, Lee & Chan, 2006). The Informal Mobile Podcasting and Learning Adaptation (IMPALA, 2006) project boasts a collection of online resources to support the wider 'pedagogical possibilities' of podcasting and related mobile learning technologies (Nie, 2006). Edirisingha, Salmon and Fothergill (2006) describe an exemplar within the IMPALA project, in which Electrical Engineering students at the University of Leicester made use of supplementary, instructor-created 'profcasts', designed to complement 'e-tivities' in line with Salmon's (2000, 2002) five-stage scaffolding model. Also within the same project, Woodward (2007) used podcasting to provide orientation to upcoming class activities in Chemistry. Similarly, Aliotta, Bates, Brunton and Stevens (in press) report on the use of prelecture podcasts to provide advance exposure to conceptually difficult topics in elementary Physics. Their study used an innovative method to assess the effectiveness of the podcasts, incorporating the use of audience response system handsets to record students' responses to in-lecture questions. Last but not least, in the language-learning domain, podcasting has been used to provide authentic experiences to students by exposing them to the foreign culture and dialogue of native speakers (Chinnery, 2006).

The authors of the present article strongly believe that the true potential of podcasting technology lies in its knowledge-creation value, and its use as a vehicle for disseminating learner-generated content. This view is echoed by Miller (2006) as well as Atkinson (2006), the latter of who believes that podcasting has limited impact as a mere method of distribution, and that '[t]he emerging developmental and research direction seems ... to be learning through *creating* podcasts and similar, in contrast to learning *from* podcasts' (p. 21, emphasis in original).

Digital audio learning objects (DALOs)

The concept of DALOs (Middleton & McCarter, 2005) combines reusable learning object theory with theory pertaining to the pedagogically sound use of digital audio to enhance e-learning. Learning objects have been the subject of much discussion and research for a number of years (Wiley, 2002). Although much effort has been expended in the development of learning object standards, implementations and applications, the volume of learning object content remains limited. Because of their relative simplicity when compared with other forms of multimedia, digital audio and podcasting offer great promise for producing and enriching learning objects. Cebeci and Tekdal (2006) also advocate applying the principles of learning objects to the design of and research into educational podcasts, to allow them to be easily used in conjunction with existing learning management systems and learning object repositories.

The key features of a well-designed DALO are as follows (Digital Audio Learning Objects, 2007):

- *Simple to produce.* They have a well-defined and limited scope, ensuring that they can be easily designed, produced and reused with little technical knowledge.
- *Immediate.* As there is no need for high-end, studio-grade equipment and/or techniques, DALOs are cheap to produce and can be made available to students in a quick and timely fashion.
- *Educationally focused.* Designing to address a well-defined learning objective ensures that the DALO will serve its original purpose. However, as with other types of learning objects DALOs may be repurposed outside the original scenario for which they were designed.
- *Reusable.* Because a DALO does not contain a lecture, it can be interpreted according to the needs of different learning contexts, either within the same or in a different course.
- *Engaging.* This is of key importance because it is challenging to keep an audience's attention for extended periods of time by using audio alone. Audio is best used selectively, for example, to capture attention, summarise and 'add colour' to the learning experience (cf. Scottish Council for Educational Technology, 1994).

By applying these design features to the generation of podcasts by students, the researchers anticipated that the learning objects produced would benefit peer listeners in their understanding of disciplinary knowledge, and also prove highly motivating and engaging for the producers themselves. The research question that framed the present study was as follows:

What sociocognitive dynamics and knowledge-building processes were evidenced in the student-producers' activity and dialogue as they created these audio learning objects for a peer audience?

The student-producers team: products and processes

A majority of the members of the student-producers team were recruited at the end of their first semester at the university, following their completion of the aforementioned ITC125 unit. They expressed an interest in contributing to the creation of podcasts for future cohorts undertaking the unit, in response to an announcement and brief overview of the project in class. Participation in the project was seen as a logical extension to the completion of ITC125, since it would give the student-producers the opportunity to reinforce and consolidate the knowledge acquired in the unit through 'teaching' it to other students, as well as allowing them to develop new, practical skills in an emerging area of Web technology relevant to their area of study.

The student-producers brought to the team varying levels of knowledge and skill, and different sets of backgrounds and experiences. They were not provided with any formal training, but rather were introduced to the various facets of podcasting by means of examples. They gradually developed competence through undergoing a number of practice runs, with decreasing levels of guidance as well as through their interactions with one another.

Table 1: Sample podcast topics

<i>Topic</i>	<i>Format</i>	<i>Knowledge focus</i>
'Oops, I missed my first lecture'	Two students converse about what happens in the first week of class	Reflections on content of the first lecture and expectations of the unit of study
'Right to copy or copyright?'	A student interviews the University's copyright coordinator	Discussion around copyright issues and their implications from a student's standpoint. (non-theoretical focus, unlike the corresponding lecture.)
'HCI today'	A student interviews a UK-based textbook author over the Internet through Skype (Skype Limited, 2007)	Coverage of topical issues of current interest/relevance in Human-Computer Interaction (HCI) research and practice.
Lecture 'trailers' (various)	Various formats—a single student addresses listeners in 'radio announcer' style; two or more students hold a dialogue with one another; a student converses with the lecturer	Previews of topics to be covered in upcoming lectures.
Topic summaries (various)	Various formats—a student voices his/her thoughts/reflections; a student responds to 'mailbag' questions; multiple students converse with one another and/or with the lecturer	Summaries of topics previously covered in lectures, for review, revision and reinforcement purposes. Usually designed to provide an alternative perspective than that which was covered in the lecture.
Case studies (various)	Various formats	An assortment of business case studies linking topics in the study schedule with real, practical applications and recent events/developments in industry.

Production of podcasts commenced with the creation of content for the Spring (July to November) 2005 semester offering of ITC125, and progressively expanded to include other units offered by the university. Podcast topics for the various units have included those listed in Table 1, among others.

The podcast production process followed by the student-producers team comprised four phases:

1. Scriptwriting and editing;
2. Presentation;

3. Audio recording and editing; and
4. Publishing and distribution.

Scriptwriting and editing

The student-producers were proactive and self-regulated in their work. They brainstormed, discussed and debated ideas for the podcast scripts during their meetings, with their lecturer providing advice and guidance only upon request. A member of the team was usually responsible for documenting ideas for later follow-up. One or two members typically took ownership of a particular script idea by agreeing to undertake the necessary research and to produce a draft script. The drafts were circulated among the group to allow opportunity for input from all members.

Presentation

As with scriptwriting and editing, the casting of roles for each 'show' was a team effort, with decisions made in a democratic manner. Members were familiar with one another's strengths and weaknesses, and through their participation in the many recording sessions, each was able to develop his/her own unique podcast 'persona'. The team typically conducted one or more informal rehearsals, during which the script was tested and appropriate modifications made. Minor changes to wording and even swapping of roles often occurred as a result of this testing, as did logistical variations in seating configurations and equipment set-up. During each recording session, the script was used as a guide or outline rather than being read verbatim. By giving the presenters the flexibility to carry out impromptu variation and improvisation at their own discretion, they were able to add a personal touch to the podcasts and give them a more relaxed, natural feel.

Audio recording and editing

Presentations were recorded in waveform (WAV) format using basic recording equipment. Editing tasks included splicing or cutting out mistakes in the presentation, reducing the length of pauses or periods of silence and decreasing the file size while maintaining an acceptable level of sound quality. The file was then exported into MP3 format for podcasting.

Publishing and distribution

The platform used for publishing and distributing the finished podcasts was a proprietary web-based publishing system (Lee, Chan & McLoughlin, 2006) originally developed by the university to provide a means for academics to disseminate electronic supplementary learning materials to students on an *ad hoc* basis throughout the semester. To facilitate the project, the system was extended to allow MP3 files containing podcasts, along with their associated Really Simple Syndication (RSS) 2.0 files (RSS Advisory Board, 2005), specifying the contents of the podcast feed, to be uploaded. This allowed listeners to subscribe to the feed using a podcatcher, or alternatively, to manually download the MP3 files by accessing the online unit outline using a standard web browser.

Theoretical underpinning of the study

Collaborative/cooperative learning

The present study is based upon and extends theoretical frameworks derived from constructivist epistemology and collaborative learning theories that view cognition as a social process (Brown, Collins & Duguid, 1989), including distributed cognition (Salomon, 1993) and situated cognition (Lave & Wenger, 1991). Although collaborative learning is a complex and often disputed term, there seems to be agreement that cooperation refers to a division of labour among participants, while collaboration involves participants engaging in a coordinated effort to complete the task (Dillenbourg, 1999). The activities of creating and recording the podcasts combined elements of collaboration and cooperation among participants, and therefore brought together a number of elements common to both constructs, ie, active learning, student self-direction, participation in group activities and team skills developed through group processes and reciprocity. The theoretical basis for the study extends beyond early research on collaborative/cooperative learning to include more recent developments in a field that is growing and expanding into the processes of inquiry-based learning and knowledge building.

Knowledge building and creation

In today's knowledge society, there is a premium on the processes of problem solving, innovation and discovery, as these are the means by which social and cultural capital are increased. The concept of knowledge has attained increasingly complex meanings, combining expertise, tacit and explicit knowledge and skilled performance. The multiplicities of knowledge are also reflected in an ever-broadening view of the competencies required of graduates, including generic skills and domain knowledge, coupled with a demand for hardcore entrepreneurship and innovation (McLoughlin & Luca, 2006).

In planning for the educational application of technology, besides technical and social infrastructure, educators and designers need to consider emerging theories and models that help to explain the role of different agents (eg, individuals, communities, networks) in knowledge creation. In contemporary society, characterised by transformation and dynamic communication, processes and mechanisms of knowledge advancement (eg, how new ideas are generated and advanced), as well as processes of inquiry (the role of questions and activities to promote learning), are now central to how we teach and learn. By combining collaborative learning with an appropriate model of knowledge construction to underpin the study, the researchers' goal was to better understand the processes by which knowledge was created collaboratively by students in the podcast production process. The study builds upon emerging conceptualisations of collaborative knowledge building by providing evidence-based examples of how participants, by creating content for an audience of peers, assume the roles as active cocreators of knowledge.

Three metaphors of learning

Knowledge-creation processes evoke a number of possible scenarios or metaphors. Sfard (1998), for example, distinguished between two metaphors of learning, the

acquisition metaphor and the participation metaphor. The former represents a receptive view according to which learning is mainly a process of acquiring chunks of information, typically delivered by a teacher. An alternative model, according to Sfard, is the participation metaphor, which perceives learning as a process of participating in various cultural practices and shared learning activities. The focus is on the process, ie, on learning to learn, and not so much on the outcomes or products. According to this view, knowledge does not exist in individual minds but is an aspect of participation in cultural practices (Brown *et al.*, 1989). Both individuals and their environments contribute to the processes of cognition, and learning is embedded in multiple networks of distributed individuals engaging in activities. By adopting a participation metaphor, learners engage in social processes of knowledge construction such as 'enculturation', 'guided participation' or 'legitimate peripheral participation', all of which are linked to sociocultural theory (Lave & Wenger, 1991; Vygotsky, 1978).

However, in order to keep pace with knowledge-building processes that are emerging in the knowledge society, it appears to be necessary to go beyond the acquisition and participation dichotomy. The present investigation utilises the knowledge-creation metaphor of learning (Paavola & Hakkarainen, 2005), which builds on common elements of Bereiter's (2002) theory of knowledge building, Engeström's (1987, 1999) theory of expansive learning, and Nonaka and Takeuchi's (1995) model of knowledge creation (see Figure 1). The knowledge-creation metaphor appears to help to overcome the separation of the cognitive (acquisition metaphor) and the situative (participation metaphor) perspectives. Knowledge creation means that knowledge is still emphasised (as in the acquisition and participation metaphors), but the processes involved are

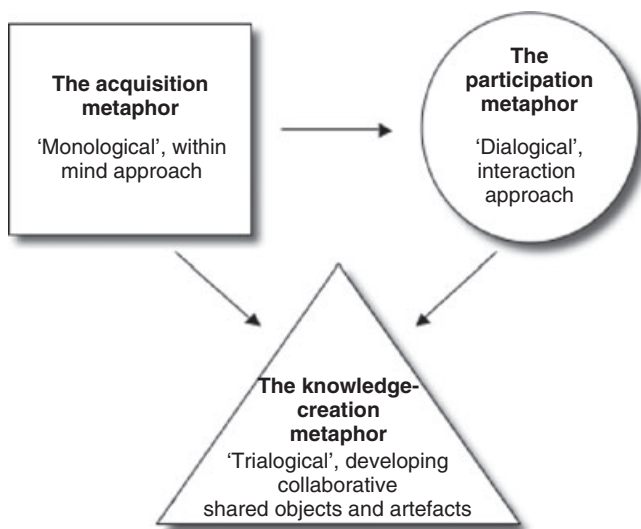


Figure 1: Three metaphors of learning (Paavola & Hakkarainen, 2005—Reproduced with permission)

different. Learners are not merely dependent on situated action alone, but actively engage in collaborative tasks and knowledge-building dialogue. They are there not to simply participate in activity and acquire skills, but also to produce shared outcomes and advance the intellectual capital of the group.

The expressions 'learner-generated content', 'peers produce knowledge' and 'users add value' are reminders that with the help of supporting tools, appropriate knowledge-building activities draw on the participants and their knowledge, enabling collaboration and the creation of shared artefacts. Scardamalia and Bereiter (2003) define knowledge building as: '... the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts' (p. 1371). In a knowledge-building community, such as that created by the podcasting team, members are managers, or 'curators' of the community's knowledge artefacts (Eustace & Hay, 2000; Lee, Eustace, Hay & Fellows, 2005), intent on making responsible decisions in addition to generating novel and innovative contributions to benefit the community as a whole.

A useful framework that synthesises and expresses the processes of knowledge building is that proposed by Scardamalia (2002), who identifies 12 key principles. These are depicted in Table 2.

The study: methodology and data-collection procedures

Focus groups were conducted to elicit the views and experiences of the student-producers, for the purpose of better understanding their knowledge-creation processes. Focus groups are particularly suited for obtaining several viewpoints on a single topic, and when compared to one-on-one interviews, have the added benefit of allowing participants to feed off one another's thoughts and ideas to fuel the discussion in a more natural setting (Marshall & Rossman, 1999).

Two focus group interviews were conducted. The first was held shortly after the first set of podcasts had been produced, in order to elicit levels of engagement and awareness of skills resulting from the experience. This initial session served as a projector in preparation for the main focus group, the results of which are presented in this article. In the main session, questions and discussion centred on the outcomes and processes of the podcasting activity, and whether students' perceptions of their involvement aligned with the knowledge-building principles as outlined in Table 2.

At the time of the study, the student-producers team consisted of eight members, of which five (three females and two males) participated in the research data collection process. Three of the participants were enrolled in the Bachelor of Information Technology (BInfoTech) degree, while the remaining two were enrolled in double degrees combining the BInfoTech with Business and Teaching programmes, respectively. The participants were provided with the interview schedule (Table 3) prior to the session.

Table 2: Twelve knowledge-building principles (Scardamalia, 2002)

<i>Principle</i>	<i>Sociocognitive dynamics</i>
Real ideas, authentic problems	Problems are ones that learners really care about—real-world issues, usually very different from textbook problems and puzzles
Improvable ideas	All ideas are treated as improvable. Learners continuously try to improve the quality, coherence and utility of ideas
Idea diversity	Multiple ideas are generated and discussed. Idea diversity creates a rich environment for ideas to evolve into new and more refined forms
Epistemic agency	Learners articulate their ideas and negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement
Community knowledge, collective responsibility	Team members read or listen to and build on the contributions of others in ways that are informative and helpful for the community, linking views to demonstrate new interrelationships. The effectiveness of the community is gauged by the extent to which participants share responsibility for generating ideas and insights
Democratising knowledge	All members are legitimate contributors to the shared goals of the community; all share in knowledge advances achieved by the group
Symmetric knowledge advancement	Expertise is distributed within the community and each member is valued. Knowledge construction results from knowledge exchange and reciprocity
Pervasive knowledge building	Knowledge building is not confined to particular occasions or subjects but is part of all activity, informal and formal
Constructive uses of authoritative sources	Learners show respect and understanding of authoritative sources, but are also able to adopt a critical stance toward them
Knowledge-building discourse	Knowledge is refined and transformed through dialogue of the team members, who have the advancement of knowledge as their primary goal
Embedded, concurrent and transformative assessment	The community engages in its own internal assessment, which is both more fine-tuned and rigorous than external assessment
Rise above	Knowledge creation and innovation entails working towards global and inclusive principles and higher level formulations. It means learning to work with diversity, complexity and messiness, and out of that achieve new syntheses

The questions in the schedule were not intended to be followed to the letter, but were to be used as a guide to keep the conversation relatively on topic. An open-ended setting was encouraged in which participants were free to talk with one another as well as with the researchers, who themselves were also active participants in the process.

Data analysis

Content analysis (Patton, 1990) was used as a method to analyse the focus group data. Content analysis is a generic name for a variety of means of textual analyses that

Table 3: Focus group questions designed to investigate knowledge creation

No.	Question	Knowledge-creation focus
1	What are the major incentives or sources of motivation driving your interest in the project, especially given the fact that your participation is not rewarded through formal academic credit?	Was there evidence of community, collaborative effort and the advancement of knowledge?
2	What gaps were you able to identify in your knowledge and skills, and how did you become aware of these? What did you do, or do you plan to do, to overcome these?	Was there evidence of progressive inquiry orientation, goal setting, and formulation of higher-level objectives?
3	How did being involved in the scriptwriting, editing and presentation of the podcasts to support the topics in the unit (2) of study benefit you? What did you learn from a subject content point of view? How about other generic knowledge and skills?	Was there evidence of knowledge-building discourse, a commitment to improving ideas and pooling expertise to generate new knowledge?
4	What lessons have you learnt from the project that might form the basis of advice and/or recommendations for other educators and groups of student-producers pursuing similar projects?	Was there evidence of pervasive knowledge building, interactive discourse, exchange of ideas and reciprocity?
5	Do you have any further suggestions on how to make this a really good experience for all those involved (student-producers, lecturers, student-listeners)?	Was there evidence of the group's capacity to work towards inclusive principles, long-term planning and complexity, and to see value in their work?

involve comparing and categorising a corpus of data (Schwandt, 2001). Modern content analysis techniques combine qualitative and quantitative approaches, which involve not only counting the occurrences of variables, but also interpreting them through a particular theoretical lens. Hara, Bonk and Angeli (2000) endorse this dual approach, noting its capacity to 'capture the richness of student interaction' (p. 119).

In devising a content analysis strategy, a fundamental issue is the choice of unit of analysis, with possible options including but not limited to sentences, messages, propositions or thematic elements. The unit of analysis chosen was the turns at talk, which in some cases contained more than one meaning unit, and were coded accordingly. Evidence was thus sought in the form of units of meaning or phrases in which the participants expressed views clearly indicative of the sociocognitive dynamics and knowledge-building processes involved. A quantitative approach enabled the researchers to search for verbal indicators of the particular themes/variables as defined by Scardamalia's 12 principles.

The analysis of the data was conducted in four steps:

1. *Transcription.* A complete transcript was first made from the audio recording of the focus group discussions. To ensure anonymity, participants' real names were replaced with aliases. The entire transcript was converted into a text file.
2. *Coding.* The next stage was to agree on a protocol for identifying and categorising the target variables/themes, and training the coders to use this protocol. Two of the researchers undertook the coding task, searching the text of the transcript for indicators. The coders' decisions were then compared to establish interrater reliability.
3. *Summarisation.* At this stage, the identified instances were collated, classified and counted.
4. *Reporting.* Finally, the results were combined and the incidence of the target variables was reported on.

Results and discussion

The results of the analysis are summarised in Table 4.

It was found from the analysis that a high proportion of the student-producers' discourse contained evidence of knowledge-building principles. The results indicate that some aspects of knowledge building were more developed, such as the category 'improvable ideas', which is a form of progressive problem solving (van Aalst & Chan, 2001) when group dialogue focuses on developing and refining ideas. A second, salient feature to emerge was 'epistemic agency', whereby students expressed their ideas, listened to divergent opinions and maintained a focus on improving the outcome.

One of the knowledge-building principles, 'constructive uses of authoritative sources', was not strongly evident in the dialogue, but the authors postulate that this may be at least partly because of the infancy of educational podcasting and the correspondingly few 'authoritative' resources available on the topic. Although the participants viewed their lecturer as an authoritative source, he had encouraged them to be as self-reliant as possible. No textbook was provided to the student-producers on the technical aspects of podcasting, but anecdotally, they reported carrying out self-directed reading of books and Internet sites in their own time, to learn about cognate areas such as digital audio production and Web server technology. On two occasions during the focus group discussion, participants also alluded to the need to undertake research to produce a script and ensure the accuracy of facts contained therein; this implicitly suggests the need to consult authoritative sources.

Overall, the results show that students engaged in idea generation, collective problem solving and reciprocal dialogue, as well as in the exchange and revision of ideas. There was in-depth engagement in collaboratively developing the podcasts for a peer audience, resulting in the production of knowledge-creation discourse. Promoting knowledge-building dialogue among learners is widely recognised as a challenging and complex issue, as it requires attention to all the intricacies and multiplicities of the learning environment (Erstad, 2002; Sorensen, 1993, Sorensen & Takle, 2001).

Table 4: Focus group results

Category	All students (and % of all discourse) (n = 247)					Examples
	S1 (n = 46)	S2 (n = 70)	S3 (n = 71)	S4 (n = 31)	S5 (n = 29)	
Real ideas, authentic problems	1	4	3	1	3	(On topic selection) '... you've got to come up with the idea, and that usually branches from ... an issue you had [personally] ...' 'I mean, you might have something you personally had troubles with ...' 'During that process, we'd then decide, well, if we want this to come into the script, can we get this to sound better ... ?' (On collaborative editing) '... you still keep what you want but make it better ...' '... someone will say, "Hey okay, this is the way you need to go," and I'll say, "Yep, all right," and I'll go have a look at a few different options ...' (On seeking the advice of others) '... [it] gives you another angle, and shares other ideas ...' [sic]
Improbable ideas	2	3	2	1	2	'... even though I don't like structure, I'm aware that other people around me ... either love it or hate it, or are in-between, so I am quite able to adapt to other people and make it work as a group.' '... the other thing with that is, it helps out other students as well. That was probably one of the main goals that I got into it for ...' '... it's about wanting to give back ...' '... we all get together and nut out a script ...'
Idea diversity	1	3	3	2	2	
Epistemic agency	2	3	2	2	2	
Community knowledge, collective responsibility	3	7	4	2	3	

Democratising knowledge	2	4	3	2	2	13 (5.3)	'... you know, I'm trying to encourage other people and hopefully they can criticise me in return ...'
Symmetric knowledge advancement	2	2	2	1	1	8 (3.2)	'I want to be involved in introducing people to podcasting ... but I didn't really have a good footing on ... all the areas involved with editing and script writing, and so I went through all these different processes ...'
Pervasive knowledge building	2	3	3	1	1	10 (4.0)	'So I need to be able to do pretty much everything, or at least know a bit of everything to be able to apply it ...'
Constructive uses of authoritative sources	2	1	1	1	1	6 (2.4)	'We came together as a team, but we all did a little bit of everything, trying to find our feet, so to speak ...'
Knowledge-building discourse	2	3	2	2	2	11 (4.5)	'See what everyone else thinks, and then if all else fails, we'd go to [the lecturer] for his opinion.'
Embedded, concurrent and transformative assessment	1	4	3	2	—	10 (4.0)	(On script editing) 'You want to get your words right. Like your sentence structure, the way you put things together ...'
Rise above	2	4	1	1	1	9 (3.6)	'... the ideas are right but maybe you need to work on a few different bits to make it work.'
All categories (and % of all discourse)	22 (8.9)	41 (16.6)	29 (11.7)	18 (7.3)	20 (8.1)	130 (52.6)	'We stumble over words, they don't make sense, or we just can't get the words out! ... we re-wrote half of our parts, because we just couldn't get it to make sense to us.'

Several supporting factors contributed to the occurrence of knowledge-building discourse in this study, apart from the podcasting technology itself, and these factors have been referred to widely in the literature on knowledge creation and collaborative inquiry. For example, the shared social context and focus on a common goal resulted in a highly cohesive team of student-producers, where mutual respect, open communication and the pursuit of a common goal were key factors that ensured ongoing exploratory dialogue and a commitment to sharing ideas, as well as to individual and group learning. These features were orchestrated by the researchers, based on the principles of collaborative learning, and enabled the establishment of the context and task (Rohde, Wulf & Stahl, 2007).

In addition to collaborative scriptwriting and editing, the presentation phase of the podcast production process allowed the student-producers to jointly and synchronously create tangible learning objects for sharing with a wider, peer audience via the Internet. Due to the nature of voice-based podcasts, during a recording session, multiple team members were able to play an active role in shaping the direction and flow of the presentation as it occurred, using the power of speech to add their contributions and to shape the final product in a real, direct way. Furthermore, the fact that the podcasts were only semiscripted, and subject to spontaneous variation and improvisation, especially where guest interviewees were involved, meant that the actual presentation was dynamic and truly dialogic. In many ways, it became an extension of the knowledge-building processes that occurred during the preceding stages of the production process. This distinguishes the exercise from applications that encourage students to work together to compose other types of verbal (eg, essay, report) or visual (eg, concept map, PowerPoint presentation) artefacts, in which team members must either take turns working on the shared object of activity, or operate on it indirectly by relying on other members to take charge of implementing the additions or changes they propose.

With that having been said, the limitations of such a small sample size are apparent, and no grandiose claims can be made on the basis of this exploratory study. Nevertheless, the commitment of students to collective responsibility and shared problem solving was evident in the dialogue that emerged, demonstrating that qualities relating to collaboration, sharing and mutual support of group members were salient features. These sociocognitive aspects are essential to knowledge advancement and the creation of community (Hakkarainen, Paavola & Lipponen, 2004).

Conclusions and future work

This article reported on a project in which a group of students engaged in a shared task of scripting and creating educational podcasts for their peers. The researchers investigated the processes of collaborative knowledge building that took place through the participants' involvement in the activity. They plan to undertake a follow-up study in which they will use cultural-historical activity theory (Engeström, 1987, 1990) as a lens through which to analyse the student-producers' actions and discourse, to gain

deeper insights into and understanding of the knowledge-creation processes as they occur *in situ* within their authentic context. From this perspective, the technology and group task may be seen as instruments or mediators of the knowledge-creation activity. In addition to retrospective verbal reports of the type relied on in the present study, several other data sources will be used to capture the details and nuances of the student-producers' interactions with one another, including notes, minutes and audio/video recordings of their team meetings, as well as transcripts (logs) of their synchronous (chat, instant messaging) and asynchronous (email) online discourse. Another ongoing challenge for the researchers is to investigate the impact of the podcasts on the peer audience whom they were designed to assist in the first instance, with particular emphasis on best practice in the design and development of student-generated audio learning objects.

Knowledge creation and discourse that leads to the generation of innovative ideas by students at all levels has become the keystone of successful learning and pedagogy, and is a measure of engagement and self-regulation. Though not an entirely new concept, knowledge creation defines successful outcomes in inquiry-based and project-based learning. There are, however, few studies that harness the affordances of technology and technology-enhanced learning environments to create contexts and processes for knowledge creation. Given the increased use and application of Web 2.0 tools, which, in conjunction with the appropriate strategies, lend themselves to supporting the collaborative creation of artefacts by learners (Lee, 2005), the authors predict a stronger move away from didactic approaches where acquisition of information and participation in social processes are sufficient, towards an increased emphasis on knowledge generation, as captured by the alternative metaphor adopted for this study (Figure 1).

Currently, much use is made of podcasting technology as a distribution mechanism to replace face-to-face teaching or to augment online lectures, and to distribute instructor-generated content. This replicates the traditional metaphor of learning as acquisition, and positions students as passive recipients of knowledge. In adopting the epistemological stance of learning as knowledge creation, the authors facilitated a project in which students were given high levels of agency, and in which the essential social processes of teamwork, dialogue and progressive problem solving were encouraged through activities surrounding the joint creation of audio-learning objects. While the products of their activity (podcast scripts and recordings) were indicators of success for the student-producers, the actual dialogic and social processes that resulted in knowledge creation were the focus of the research inquiry. The authors believe that without the articulation of common goals and the commitment to producing tangible objects of shared activity, the student-producers may not have been as actively engaged in these collaborative processes.

The study has a number of implications for teachers and instructional designers in diverse education settings where podcasting facilities can easily be established. First, the students in the present study found the task both challenging and motivating, as evidenced by the quality and intensity of their interaction and by the successful production

of the podcasts. Instead of using the technology to merely deliver content, the authors advocate greater student control and ownership of the technology, and its use as a means for encouraging collaboration. Podcasting also holds great potential for allowing students to articulate their understanding of ideas and concepts, and to share the outcomes with an audience they value, such as their peers as in the present study. Second, students may not always realise that the actual processes of interactive dialogue and collective problem solving are essential to knowledge creation, and may become overly focused on the technology—this makes it important to scaffold cognitive behaviours and encourage collaborative discourse by establishing a shared goal, highlighting the importance of sociocognitive dynamics and emphasising the supportive role of information and communications technology as a mediating artefact. Students need to become increasingly aware that knowledge is not constituted simply by individual effort, but collectively. This calls for them to be actively involved in their own and others' learning trajectories.

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